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The Third Time's A Charm: Psychometric Testing and Update of the Atlanta Heart Failure Knowledge Test

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Abstract

Background and Objective—Since first published in 2009, the Atlanta Heart Failure Knowledge Test (AHFKT) has proven a reliable and valid instrument and has been used in multiple studies. Given advances in heart failure (HF) self-care, we proposed to reevaluate the psychometric properties of the AHFKTv2 across these recent studies and update the instrument.

Methods—Demographic, clinical, and baseline AHFKTv2 data from 4 intervention studies in persons with HF were combined for this analysis (N=284). The 30 questions of the AHFKT are focused on 5 HF self-care knowledge domains: pathophysiology, nutrition, behavior, medications, and symptoms. Characteristics of the sample were analyzed using descriptive statistics; validity testing with t tests and Mann-Whitney two-group tests, Pearson's *r* and Spearman's rho correlations; and reliability calculations and factor analysis were performed based on tetrachoric correlations.

Results—Participants were 22 to 84 years of age, 66% African American, 63% male, and 94% NYHA class II–III. Mean AHFKT score was 80.6% ($\pm 11\%$). Hypotheses that higher levels of knowledge would be associated with higher education level ($t=-2.7$, $p<.01$) and less sodium consumption ($\rho=-.22$, $p=.03$) were validated. Factor analysis revealed one general knowledge factor with good reliability, Cronbach's alpha was 0.87. Item response analysis identified individual questions requiring review and revision.

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Conclusion—Comprehensive psychometric evaluation of the AHFKTv2 confirmed its internal consistency reliability and validity, and provided direction for production of the AHFKTv3 available for use in research and clinical practice.

Introduction

Persons with heart failure (HF) constitute the largest population of healthcare recipients with an excess of 1 million annual hospital discharges and total costs estimated to be \$30.7 billion in the estimated 5.7 million Americans diagnosed.¹ Despite multiple initiatives from providers, hospitals, organizations, and government mandate to decrease readmissions through reimbursement penalties, 30-day Medicare hospital readmissions remain above 20%.² Patient adherence to self-care instruction is low with varying reported adherence (2–90%) to usual recommended self-care activities such as daily weights, and limiting dietary sodium, fluid, and alcohol.³ These deficits in self-care undoubtedly contribute to the high recidivism rate in persons with HF.³

This burden of daily management of HF falls squarely on the shoulders of the HF patient and caregivers. Patients must have the knowledge and ability to adhere with self-care activities such as monitoring dietary intake of sodium and fluid, regular physical activity, polypharmacy, and daily monitoring for symptoms and then adherence with prescribed actions.^{3,4} While patient knowledge cannot guarantee adherence with necessary self-care activities, behaviors most certainly cannot be changed without it. Thus, having the ability to assess this knowledge with a well-validated and reliable instrument to provide additional instruction in identified areas of weakness is an important tool in the armament of the clinician or researcher assessing HF self-care knowledge.

Background and Significance

The Atlanta Heart Failure Knowledge Test was originally developed to knowledge about HF, treatment, and self-care. Published in 2009 and available for use by any clinician,⁵ Version 2 included 30 questions measuring the domains of patient education related to the HF disease process, diet and nutrition (including sodium and fluid restriction), medications, symptoms, and behaviors (such as daily weighing and physical activity). When published in 2009, the manuscript included the psychometrics of version 1 explored in both patients and family members, noted revisions from version 1 to 2, and acknowledgment of the need for a full factor analysis with a larger sample.⁵ In the intervening six years, we have been able to pool data from four additional studies, thereby allowing for a more comprehensive psychometric evaluation.

As new evidence for heart failure care evolved, we recognized the need to review and revise the instrument with current standards and evaluate strengths and weaknesses of individual questions. Since originally published six years ago, the AHFKT has been used in multiple studies^{6–11} and requests to utilize and translate this instrument in 15 languages for use in both clinic and research settings.¹² A recent systematic review of knowledge measures suggested the AHFKT may be the most appropriate measure for assessing HF knowledge, but was criticized for failure to describe the theoretical background and judged to have some

methodological limitations.¹³ Thus, the purpose of this article is to address these identified issues, present data from a pooled cohort of 4 studies allowing us to re-examine the psychometric properties of the AHFKT-v2 in 284 patients, and provide a revised AHFKT-v3.

Theoretical Constructs

The conceptual framework published in 2008¹⁴ and guiding the development of AHFKT was synthesized from the literature on self-management in chronic disease and HF, and self-determination theory.^{15,16} Persons with HF are required to perform significant self-care including making lifestyle changes and managing their symptoms and treatment. Self-management involves a process of cognitive decision-making, goal setting, developing personal action plans, and overcoming barriers in performing health behaviors.^{17,18} Effective self-management behaviors are also influenced by antecedents of sociodemographic factors, clinical and illness factors, and behavioral and psychological factors including experience with self-management and decision-making.¹⁹ Prerequisite knowledge and skills, attention and rational involvement, and motivation to participate are required.^{20,21} The AHFKT was developed to assess the knowledge that is prerequisite to adequate and comprehensive self-care and can be differentiated from other instruments that are focused more on patient beliefs, self-efficacy, or adherence.²²⁻²⁴

Clinical advances

Perhaps the single largest change related to HF self-care education since the instrument was first published is the recommended dietary sodium intake for persons with HF. Since 2005, the recommendations for limiting dietary sodium have become more stringent with the general population advised to consume no more than 2.3 grams of sodium per day,^{25,26} and persons at high risk for CVD or hypertension to limit sodium to 1500mg per day.²⁷ This led many clinicians to suggest a greater reduction for persons with HF, falling back on the basic principles of sodium-induced fluid retention. While the concept of less sodium leading to less fluid congestion appeared straightforward, recent studies suggest that sodium restriction triggers sympathetic nervous system and renin-angiotensin system activation, exacerbating rather than relieving congestion,²⁸ concluding that very low sodium dietary intake in persons with heart failure may be harmful.²⁹ Thus, sodium restriction in persons with HF is currently a Class C level recommendation.³⁰

To date, no large-scale study of outcomes in outpatients randomized to various levels of sodium restriction has been completed. Thus, until further research can guide practice, the AHFKT has been revised based upon the current AHA,³⁰ HFSA,³¹ and AAHFN³² guidelines that recommend a total daily consumption of sodium less than 3000mg in persons with heart failure. We similarly used this 3000mg sodium level as the cut point for determining adherence with self-care guidelines in this analysis.

Methods

Sample

Data from four self-care intervention studies in persons with HF were combined for this analysis (N=284). Inclusion criteria for each study are listed in Table 1. All patients were recruited from a current (studies 1, 2 and 3)³³⁻³⁵ or recent (study 4)³⁶ HF hospitalization with discharge to the home setting. All patients received optimal HF medication regimen (unless contraindicated) of beta-blocking agents, angiotensin-converting enzyme (ACE)-inhibitors or angiotensin receptor blockers (ARBs), and diuretics if indicated by fluid status. Most patients had significant comorbidities in addition to HF, and two of the studies (studies 2 and 3) specifically targeted participants with both HF and type II diabetes mellitus (DM). All data was de-identified prior to assimilation and analysis. IRB approvals for the parent studies allowed for secondary data analysis of de-identified data.

Variables and Measures

Patient demographic and clinical data were obtained from patient history and the medical record. All participants completed the AHFKT at baseline. Individual responses were recorded and coded as correct or incorrect. The total number of correct answers were calculated and presented as sum score (out of 30 possible correct) or percent correct (up to 100%).

Highest education level attained and dietary sodium ingestion were used for construct validity. Dietary sodium ingestion was calculated by 24-hour food recall (study 3) or 24-hour urine collection (studies 1 and 4). Dietary sodium ingestion was not available at baseline for study 2, and this study was excluded from construct validity assessment with dietary sodium ingestion. For construct validity, we hypothesized that HF knowledge would be positively associated with education level and negatively associated with dietary sodium ingestion.

The self-care confidence scale of the Self Care in Heart Failure Index Version 6.2³⁷ (SCHFI) was used to assess self-efficacy in HF in two of the studies (2 and 3) and is comprised of six items reflecting confidence in recognizing symptoms and taking HF self-care actions.” The total score can range from 0 to 100, with higher scores indicating more confidence in managing heart failure and scores of 70 and higher indicating adequate self-care.³⁷ Internal reliability consistency is acceptable for the scale ($\alpha = .82$). We hypothesized that greater knowledge would be associated with higher confidence as a measure of criterion validity.

Data Analysis

Data were examined for missingness; subjects were excluded from analysis if nine or more questions on the AHKFT were left unanswered. All unanswered and skipped questions were coded as incorrect. Characteristics of the sample by study group were analyzed using descriptive statistics. Internal consistency and reliability were analyzed using Cronbach’s alpha computed from tetrachoric correlations (using the dichotomized (0 vs. 1) item scores). Construct validity was assessed through parametric t-tests and Pearson *r* correlations and non-parametric Mann-Whitney two-group tests and Spearman’s rho for ordinal and skewed

measures. All statistical tests were performed at the 5% significance level. While the analyses presented here represent a secondary analysis from 4 combined datasets, given the final sample size of 284 subjects, we were powered at 80% power to detect small effect sizes ($r = 0.165$). Statistical software SPSS (Version 23.0, IBM Corporation, Armonk, NY) and R (v.3.2.5, R Core Team, 2015) were used to analyze data.

As the basis for reliability calculations and factor analysis, tetrachoric correlations (using the dichotomized (0 vs. 1) item scores) were computed.³⁸ The factor analysis and reliability calculations were performed using R packages: psych³⁸, GPArotation³⁹, and nFactors⁴⁰. After performing factor analysis, Cattell's scree plot, very simple structure (VSS), Velicer's minimum average partial correlation (MAP), and acceleration factor methods were used to confirm a single factor.³⁸ Additional details on all of these methods and R packages are available from the Personality Project online (<http://personality-project.org/r/psych/>).

Results

Sample Description

Sample demographics and clinical characteristics are listed in Table 2. The combined sample of participants were 22 to 84 years of age, 66% African American, and predominately male. Approximately one-half of the participants had a spouse or domestic partner. The majority of participants had lived with HF for greater than six years, while only 18 percent were newly diagnosed within the prior six months.

Psychometric Properties

Participants in the combined sample had a mean AHFKT score of 80.6% ($\pm 11.1\%$), which is equal to answering 24 of 30 questions correctly (Table 4). Psychometric properties of the AHFKTv2 are presented according to the precepts published by Terwee for quality measurement properties needed to legitimize a health status questionnaire (Table 3).³⁸ While not necessary for a study to conduct all types of psychometric property analysis in order to have a valid questionnaire,³⁹ these components include (1) content validity, (2) internal consistency, (3) criterion validity, (4) construct validity, (5) reproducibility, (6) responsiveness, (7) floor and ceiling effects, and (8) interpretability.⁴¹ We have summarized the bulk of the psychometric evaluations in Table 3 whereby we listed the components, definitions, hypotheses, measures and the statistics/evaluation of each component evaluated for the AHFKT.

Content Validity

As presented in the original paper, the original AHFKT was evaluated by a panel of nationally known nurse experts in HF patient education and self-care, selected based upon their research and scholarship leadership. At that time, each expert rated items for clarity and relevance such that scale level content validity indexes and clarity item level scores were calculated. Each of these was rated to be good or excellent.

Readability is a component of content validity that assesses the comprehension of the instrument by grade level. The goal for most patient education materials and text is a fifth-

grade reading level for best comprehension. Using the readability function for Word, AHFKTv2 calculated to have a Flesch-Kinkaid reading level of 5.8 and a Fry Readability 4th grade reading level (Table 3).

Internal Consistency

The internal consistency of the AHFKT for the combined sample for all 30 items was adequate, Chronbach's alpha 0.87 (Table 3). The 30 questions of the AHFKT were focused on five knowledge domains: pathophysiology, nutrition, behavior, medicine, and symptoms (primary domain focus of each item listed in Table 4). When the knowledge scores were computed for each domain (summarized at the bottom of Table 4), these 5 domain scores are positively and significantly correlated with one another (Table 5) with the strongest correlations between the nutrition and medication domains ($\rho=0.43$, $p<.001$) and between nutrition and symptoms ($\rho=0.37$, $p<.001$). Additionally, the nutrition domain had the highest correlation with the overall total knowledge score ($\rho=0.802$, $p<.001$) followed by medications ($\rho=0.73$, $p<.001$) with all 5 domains having moderate-to-large correlations with the total score (all $\rho>0.44$, Table 4).

Criterion Validity

Criterion validity evaluates the extent to which the instrument is related to a gold standard. While there is no gold standard instrument for the testing of heart failure knowledge, the AHFKT was developed to measure knowledge about HF treatment and self-care using the American Heart Association Scientific Statement on HF self-care³, the 'gold standard' prescription of HF self-care. Because self-care knowledge has been previously positively associated with self-efficacy related to self-care in several studies,⁴²⁻⁴⁴ we validated a positive, but weak relationship between higher scores on the confidence subscale of the SCHFI and total knowledge on the AHFKT ($N=170$, $\rho=.16$, $p=.04$).

Construct Validity

Testing of several hypotheses concerning the AHFKT construct validity was undertaken to show the relationship between knowledge, demographic background, and behavior. Higher AHFKT scores were associated with higher educational level and lower sodium intake (Table 3).

Factor Analysis

Four methods were used to confirm there was one factor: the acceleration factor, Velicer's MAP, Cattelle's scree plot, and VSS.³⁸ These metrics all indicated a strong first factor with the 23% of the variance explained by the first factor. All factor loadings were 0.29 and higher (Table 4) except for items 16 and 27. Items 16 and 27 had factor loadings and discrimination indices close to 0. The majority of the items had a good range of difficulty with 50%–80% of the subjects getting the item correct. Item 9 had the highest difficulty with only 19% getting it correct and items 3 and 8 were the least difficult with more than 98% of the subjects getting these correct (Table 4).

Discussion

This paper describes the evaluation and further revision of the AHFKT. The purpose of this article was to re-examine the psychometric properties of the AHFKT-v2 in a larger cohort of patients, and provide a revised AHFKT-v3. We also evaluated the extent to which participants accurately understood HF self-care, described the relationship between items and undertook further reliability and validity testing to assure trustworthiness of the instrument and enhance readiness for use, so that it may be relied upon for application in research or in evidence based practice.⁴⁵

Overall, content validity and readability were excellent and unchanged from the first assessment. Nurse experts reviewed each version of the AHFKT when they were made available and consistently rated each item at the time as good or excellent based upon the current guidelines at that time. Internal consistency improved from the previous AHFKT version, with strong correlations between the domains, and Cronbach's alpha closer to 1. Several measures of validity were undertaken based upon hypothesis testing that improved self-care knowledge is associated with improved self-care confidence and behaviors. As shown in Table 3, while these validity assessments were statistically significant some had small effect sizes (correlations < 0.2). These smaller effect sizes may have partially been due to increased variability occurring from using a combined dataset across four different studies as opposed to having all of the subjects from a single study. Factor analysis allowed us to observe a dominant single factor, correlations between the 5 domains of knowledge, and further validate questions requiring revision. Finally, the instrument was demonstrated to be responsive to the length of time since diagnosis.

Revision of the AHFKT

In total, eight questions on the AHFKT were revised with one eliminated and one added to strengthen the psychometric properties of the instrument. The items revised were those with great difficulty, very low discrimination, and/or poor factor loadings. We added one question on beta blockers as current guidelines recommend prescription for both HF with reduced (HFrEF) as well as preserved (HFpEF) ejection fraction.³⁰ The result is a final 30 item questionnaire.

The majority of the exam focuses on the knowledge to appropriately adhere to the self-care demands of HF. Thus, we retained the focus on 5 domains of pathophysiology, medication, behavior, symptom management, and nutrition. To make the test more useful in clinical application, we have developed a teaching guide based on these domains to facilitate teaching to the patient's learning needs. Ideally, the results of the whole test could be reviewed with the patient and or family for the purpose of reinforcing their knowledge, with their knowledge gaps guiding additional and more precise education.

Limitations

In revising the test, one of the aspects with which we struggled was a ceiling effect with average scores of 80% correct responses and very high difficulty measures with most of the individual items. When evaluating the difficulty with the percent of items answered

correctly, 22 of the items were answered correctly greater than 80% of the time, 7 of the items answered correctly greater than 50% of the time, and only 1 item consistently answered incorrectly. For version 2, the overall item difficulty was .81, whereas typically, the goal difficulty mean should equate to .50 providing “maximal discrimination”.⁴⁶ However, reexamination of the sample revealed most had been living with HF for six years, and thus were not at the beginning of their HF journey when learning needs are steep. Higher total scores on the AHFKT were associated with longer length of time with HF. This is congruent with studies that self-care behaviors and knowledge increase with length of time that persons are living with HF. Further studies testing HF knowledge in persons newly diagnosed with HF may address this ceiling effect and prove to be a useful clinical tool in targeting self-care knowledge deficits for both inpatient and outpatient settings. The cut point for version 2 was determined to be 80%, and we would suggest that any person making less than this with version 3 be identified as having insufficient HF self-care knowledge necessitating remediation. Ultimately, this will need to be validated once scores for a sufficient sample are obtained

Further research is needed to determine a more in-depth scientific understanding of what level of specific HF knowledge is required for effective self-care.⁴⁷ For example, is the ability to select low sodium items from a list of foods adequate for effective self-care, or is the skill of label reading and application to a decision about whether it can be consumed given other daily intake required? Moreover, does this knowledge translate to application of self-care behaviors? Further studies examining HF knowledge, self-care, and outcomes are needed.

Conclusion

Heart failure is the leading cause of mortality in those over 65, touching over 23 million persons worldwide.⁴⁸ Prognosis and recidivism remain poor, yet those who practice good self-care have been observed to have better outcomes and consume less health care resources.³ Knowledge of HF pathophysiology, nutrition, behavior, medicine, and symptom management is essential to this self-care. While the AHFKTv2 has been used extensively since published, we have taken this opportunity to evaluate the instrument further, revise it, and now produce a free 3rd version for use in clinical practice and research.

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Table 1

Sample Inclusion and Exclusion Criteria by Study

STUDY 1 (N=82)	<ul style="list-style-type: none"> • 18–85 years of age • Acute HF hospitalization with planned discharge home • Optimal HF medication regimen • Ability to read, write, and speak English • Ambulatory • Telephone Access
STUDY 2 (N=60)	<ul style="list-style-type: none"> • 21–80 years of age • Hospitalized with admitting diagnoses of HF and planned discharge home or hospitalized with HF within previous six months • Concomitant type II diabetes mellitus treated with oral agents • English fluency • Without cognitive impairment on screening test
STUDY 3 (N=117)	<ul style="list-style-type: none"> • 21–80 years of age • Hospitalized with admitting diagnoses of HF and planned discharge home or hospitalized with HF within previous six months • Concomitant type II diabetes mellitus • NYHA Class II–IV • Optimal HF medication regimen • Ambulatory • Able to read and write English • Without cognitive impairment on screening test
STUDY 4 (N=25)	<ul style="list-style-type: none"> • NYHA Class II–IV • Hospitalized for HF within the previous six months • Able to read, write, and speak English • Optimal HF medication regimen • Prescribed fluid restriction of 1.5 to 2 liters per day • Telephone access

HF – Heart Failure

NYHA – New York Heart Association

Table 2

Demographic and Clinical Data for the Combined Sample (N=284) and by Study

Variable Combined Sample N=284	m ± sd, range N (%) Median [IQR]
Age (years)	56.48 ± 11.8 22 – 84
Gender	
Male	177 (62.8)
Female	105 (37.2)
Race	
African American	184 (65.7)
White	93 (33.2)
Asian	3 (1.1)
Married/DP	146 (51.8)
Education	
High School	111 (39.5)
Ejection Fraction (%)	30.39 ± 16.1 5 – 65
NYHA Class	
I	1 (0.4)
II	106 (40.3)
III	141 (53.6)
IV	15 (5.7)
Time with HF	4 [1, 9]
Diabetes	216 (76.6)
Sodium (3dfr) *	2025 [1452, 2956.5]
Sodium (24hr Urinary) **	3565 [2243, 5279]

DP = Domestic Partner, NYHA = New York Heart Association

* Sodium 3dfr was obtained for n=192 (66 Study 1; 0 Study 2; 102 Study 3; 24 Study 4)

** Sodium 24 hr urinary was obtained for n=88 (63 Study 1; 0 Study 2; 0 Study 3; 25 Study 4)

Table 3

Psychometric Properties of the Atlanta Heart Failure Knowledge Test

Component	Definition	Hypothesis	Measure	Statistics/Evaluation
<i>Content Validity</i>	The extent to which the topics of interest are comprehensively illustrated by the items in the instrument. Readability is a component of content validity that assesses the comprehension of the instrument by grade level.	The AHFKT will have a good description of measurement aim, target population, concepts being measured, and item selection. The AHFKT will have a fifth-grade reading level.	Panel of nurse experts in HF patient education and self-care rated items for clarity and relevance such that scale level content validity indexes and clarity item level scores were able to be calculated. Flesch-Kincaid reading level Fry Readability	Each was rated as good or excellent. 5.8 ^a 4 th grade
<i>Internal Consistency</i>	The degree of correlation among the items of a questionnaire, measuring the same concept and justifying the items on the same scale.	Reliability coefficient values will be > .60.	Chronbach's alpha	0.87 ^b
<i>Criterion Validity</i>	Criterion validity evaluates the extent to which the instrument is related to a standard.	Total knowledge scores will be positively related to HF self-efficacy.	SCHFI confidence subscale Non-parametric correlation analysis	rho=.158, p=.04 (n=170)
<i>Construct Validity</i>	The extent to which scores on a particular instrument relate to other measures in a manner that is consistent with theoretically derived hypotheses concerning the concepts that are being measured.	Participants who attended college will score significantly higher on the AHFKT than those with a high school diploma or less. The sum of the eight questions related to sodium knowledge and restriction will be negatively related to 24-hour sodium intake. Participants adherent to sodium recommendations will answer more questions correctly related to sodium knowledge and restriction	Highest educational level attained Student's t-test 24 hour urine collection Non-parametric correlation analysis Adherent to daily sodium intake recommendations (3000 mg) based on 24 hour urine collection or 3-day food diary Mann-Whitney test	t=-2.70, p=.007 ^c rho=-.233, p=.03 ^d 24 hour urine intake: Z=-3.014, p=.003 ^e 3-day food record: Z=-1.997, p=.046 ^f
<i>Responsiveness</i>	The capacity of an instrument to detect clinically important changes over time and often assessed by testing predefined hypothesis.	The number of years an individual has lived with HF is positively associated with HF knowledge.	Time living with heart failure (years) Correlation	rho=.141, p=.02
<i>Interpretability</i>	The degree in which a person can assign qualitative meaning to quantitative scores.	The AHFKT will identify gaps in knowledge and need for additional teaching.	AHFKT individual scoring	Subject areas of questions missed

AHFKT – Atlanta Heart Failure Knowledge Test

HF – Heart Failure

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^gThis is overestimated since a knowledge test does not appear to have distinct sentences beyond the original stem. To assess for the number of sentences and syllables in groups of 100 words and assuming each answer is an independent sentence, the Fry Readability was calculated.

^hTable 4. Using the psych package in R, Cronbach's alpha was computed using the omega function on the tetrachoric correlations based on dichotomous scoring (correct/incorrect) of the items.

^cCollege (N=170): 81.98 ± 10.23%; less than high school diploma (N=111): 78.41 ± 11.69%

^dItems 3, 18, 19, 20, 21, 22, 25, 27. No significant relationship was found for the patient-reported food diary (rho=-0.069, p=.340).

^eAdherent: Median 100%, IQR [88%, 100%]. Non-adherent: Median 88% [75%, 88%].

^fAdherent: Median 88% [75%, 100%]. Non-adherent: Median 81% [75%, 88%]

Table 4
Percent Correct, Discrimination and Factor Loadings by Item, Total Knowledge, Domain Scores, and Reliability

Item Question	Domain	Percent Correct	Item Discrimination	Factor Loading
1. Heart Failure is a problem in which:	P	79.2%	0.366	0.344
2. Which of the following statements about heart failure is TRUE?	P	81.3%	0.572	0.497
3. Avoid salty foods	N	98.6%*	0.515	0.458
4. Drink lots of fluids	N	79.9%	0.746	0.598
5. Stop smoking	B	93.3%	0.419	0.386
6. Drink alcoholic drinks each day to relax	B	94.7%	0.547	0.480
7. Skip heart failure medicines when they feel better	M	96.1%	0.911	0.674
8. Know when to call the doctor or nurse for symptoms of heart failure	S	98.2%	0.709	0.579
9. ACE inhibitors are medicines used to treat heart failure. These drugs help the heart pump stronger by:	M	18.7%	0.443	0.405
10. People who have heart failure take diuretics so that:	M	80.3%	0.444	0.406
11. People with heart failure who are taking a diuretic need to:	M	83.5%	0.729	0.589
12. If a person with heart failure gains 2-3 pounds in a few days, this usually means he/she:	S	94.4%	0.885	0.663
13. How often should a person with heart failure weigh themselves?	B	97.2%	0.543	0.477
14. The best time of day for persons with heart failure to weigh themselves is:	B	92.6%	0.813	0.631
15. Persons with heart failure should call their doctor if they have which of the following symptoms?	S	91.5%	0.662	0.552
16. How often should a person with heart failure exercise?	B	58.1%	-0.007	-0.007*
17. A person with heart failure should stop and rest when doing physical activity if:	S	96.1%	0.759	0.604
18. Which is a big source of sodium (salt) in the diet?	N	95.4%	0.724	0.586
19. Which has the LOWEST amount of sodium?	N	92.3%	0.438	0.401
20. Which food has the MOST sodium (salt)?	N	94.4%	0.620	0.527
21. Which dessert has the LOWEST amount of sodium?	N	63.4%	0.589	0.507
22. Select the fast food with the LOWEST amount of sodium.	N	78.2%	0.376	0.352
23. Some people with heart failure are told by their doctor to limit fluids. Which of the following count as fluids?	N	84.5%	0.467	0.423
24. If a person with heart failure has a headache or pain, which would be the best medicine to take?	M	55.3%	0.456	0.415
25. The recommended total daily amount of sodium that persons with heart failure should eat is:	N	53.9%	0.303	0.290
26. How many servings are in the can?	N	82.7%	0.638	0.538
27. How much sodium is in one serving of soup?	N	84.5%	0.041	0.041*

Item Question	Domain	Percent Correct	Item Discrimination	Factor Loading
28. A person with heart failure who is trying to limit their fluids may reduce symptoms of thirst by:	S	55.3%	0.515	0.458
29. If a person with heart failure forgets to take their medicine, they should:	M	55.3%	0.325	0.309
30. It is important for a person with heart failure to:	B	88.0%	0.391	0.364
Reliability (α)	0.87			
Knowledge Scores (% correct)	Mean (SD) or Median [IQR]			
Total (all 30 items)	80.6 (11.1)			
Sodium Items (8 items: 3, 18-22, 25, 27)**	88 [75, 88]			
Domain: Pathology Knowledge (2 items)	100 [50, 100]			
Domain: Nutrition Knowledge (11 items)	82 [73, 91]			
Domain: Behavior Knowledge (6 items)	83 [83, 100]			
Domain: Medication Knowledge (6 items)	67 [50, 83]			
Domain: Symptoms Knowledge (5 items)	80 [80, 100]			

Domains: P=Pathology; N=Nutrition; B=Behavior; M=Medication; S=Symptom

* Item 3 had low difficulty (98.6% got it correct); items 16 and 27 had the lowest (near 0) discrimination and factor loadings

** Items 3, 18, 19, 20, 21, 22, 25, 27 highlighted in light grey – all 8 items focus on Sodium restriction and dietary management

Correlations (Spearman's Rho) among the Five Domains of the Atlanta Heart Failure Knowledge Test and with the Total Knowledge Score

Table 5

Measure	Nutrition	Behavior	Medications	Symptoms	Total
Pathophysiology	0.197	0.151	0.251	0.239	.441
Nutrition	1	0.184	0.433	0.374	.802
Behavior		1	0.206	0.241	.456
Medications			1	0.235	.734
Symptoms				1	.569

Note: all correlations are significant at $p < .01$.